THE EFFECT OF TENDERSTRETCHING AND ELECTRICAL STIMULATION ON THE TENDERNESS OF TWO ALPACA (*Vicugna pacos*) MUSCLES

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Abstract – Thirty-six castrated male huacaya alpacas were slaughtered on the South Coast of NSW, Australia. Carcases were split in half at processing and randomly allocated to one of four treatment groups in a 2 x 2 factorial (Achilles hung and no electrical stimulation (AH + No ES; CON); Achilles hung and electrical stimulation (AH + ES); Tenderstretched and no electrical stimulation (TS + No ES); and Tenderstretched and electrical stimulation (TS + ES)). At 24 hours, the *m. longissimus* (LL), and *m. semimembranosus* (SM) were removed. A 5 g sample was frozen for subsequent sarcomere length (SL) measurement and 80 g aged for 10 days prior to shear force and ultimate pH testing. There was no treatment interaction within muscles. Electrical stimulation (ES) resulted in longer LL SL ($P < 0.05$) and lower SF ($P < 0.001$) values while tenderstretching (TS) resulted in longer SL and lower SF ($P < 0.001$) in the SM. These findings demonstrate that tenderstretching and electrical stimulation should be applied in combination in order to maximise tenderness of alpaca carcases on a whole carcase basis.

Key Words –processing treatments, meat quality, exotic species

I. INTRODUCTION

Previous research on Australian alpacas has identified many limitations in carcase processing, limiting the ability to deliver a tender product to consumers [1]. Since tenderness is one of the main drivers of consumer satisfaction, improvements in the slaughter process that improve tenderness will have significant marketing and financial importance to producers and the industry as a whole. Previous research has indicated that processing techniques such as electrical stimulation (ES) and tenderstretching (TS) improve tenderness in different areas of the carcase. Electrical stimulation has been shown to improve tenderness in the *m. longissimus* [1, 2] while TS has a positive effect on hind quarter muscles through increasing tension on muscle fibres, thereby physically preventing shortening [3]. To date, the effect of these two processing techniques applied in combination on multiple alpaca muscles has not been reported. Therefore, the aim of this research was to investigate the effect of combining TS with ES on the tenderness of multiple alpaca muscles, in order to examine the potential additive effects of these two techniques across a whole carcase.

II. MATERIALS AND METHODS

Thirty-six castrated male huacaya alpacas were slaughtered two months apart (9/03/2016 and 4/05/2016; n = 18 animals per processing) at a commercial abattoir on the South Coast of NSW, Australia. Carcases were split in half down the vertebral column prior to treatment application. Each carcase side (n = 72) was assigned to one of four treatment groups in a 2 x 2 factorial arrangement (n = 18 sides per treatment). Treatments included 1) Achilles hung and no electrical stimulation (AH + No ES; CON); 2) Achilles hung and electrical stimulation (AH + ES); 3) Tenderstretched and no electrical stimulation (TS + No ES); and 4) Tenderstretched and electrical stimulation (TS + ES).

Stimulation was applied using a portable STIMTECH medium voltage electrical stimulation unit set to ~300 V, delivering 600 mA peak current at 68 ms pulse interval and 1000 µs pulse width for 40 s. Carcase sides were tenderstretched through suspension by the pelvic bone for the duration of chilling. At 24 hours post slaughter, a 5 g sample was taken from the *m. longissimus* (LL) and *m. semimembranosus* (SM) of each carcase half and stored at –20 ºC until sarcomere length (SL) measurement. Samples of approximately 80 g were cut from the remaining muscle, vacuum packaged and chilled at an average of 3.1 ºC and 75 % humidity for 10 days. Post-aging, samples were prepared into a 65 g block for shear force (SF) analysis and a 5 g sample for the determination of ultimate pH (pHu). Shear force and pHu samples were frozen at – 20 ºC until subsequent analysis. Sarcomere length was analysed using laser diffraction [4]. Shear force samples were cooked and analysed using a Lloyd fitted with a Warner Bratzler v shear blade [5]. Ultimate pH samples were homogenised in buffer and measured at 22 ºC [6].

Sarcomere and SF data for the two muscles (LL and SM) was analysed separately using linear mixed models in Genstat (18th edition). Fixed effects for full models included hang and stimulation treatments, a treatment interaction term, ultimate pH and carcase side, as well as SL for SF models. Treatment interaction was dropped from all models. Likewise, ultimate pH was dropped from all models, excluding the LL sarcomere model, due to non-significance. Carcase and kill day were included as random effects in all models. Cook batch and cook date were added as further random effects within SF models. Predicted means, standard errors and P–values were extracted from all reduced models. Shear force data for the SM were log transformed prior to analysis on the basis of non-normality and all predicted means and standard errors appropriately back transformed for reporting.

III. RESULTS AND DISCUSSION

Hang method did not affect (P = 0.80) LL SL, while LL from carcases not exposed to stimulation had shorter SL (P < 0.05) by 0.08 (± 0.04) µm (Table 1). Stimulation lead to lower SF values (P < 0.001), but hang had no effect (P = 0.71; Table 1). Shear force was 23.9 N higher in muscle from non-stimulated carcases. This is in line with the findings of a previous study in alpaca [1], where stimulation reduced SF in 5 and 10 day aged alpaca LL by 21.6 N. The average values for ES and No ES LL SF in the current study are also in line with this past study.

Table 1. Predicted means and standard errors for muscle shear force (SF) and sarcomere length (SL) at each treatment level (stimulation and hang) and on an individual muscle basis (*m. longissimus*; LL, and *m. memimembranosus*; SM).

	Stimulation		Hang	
	Yes	No	Achilles hung	Tenderstretch
SL (µm)				
LL	1.83 ± 0.03[a]	1.74 ± 0.03[b]	1.78 ± 0.03[a]	1.79 ± 0.03[a]
SM	2.10 ± 0.04[a]	1.96 ± 0.05[b]	1.82 ± 0.04[b]	2.24 ± 0.05[a]
SF (N)				
LL	60.2 ± 3.33[b]	84.1 ± 3.32[a]	72.7 ± 3.30[a]	71.6 ± 3.34[a]
SM	45.2 ± 1.04[a]	46.1 ± 1.04[a]	50.7 ± 1.04[a]	41.2 ± 1.04[b]

Superscripts are not applicable to means in different rows.

Within the SM both hang and stimulation had an effect on SL (P < 0.001 and P < 0.05 respectively). Tenderstretching increased SL (Table 1), in line with previous literature [3, 7], while SL within the SM of non-stimulated carcases were 0.14 (± 0.06) µm shorter than in muscle from stimulated carcases. This minor stimulation effect on SM SL did not transfer to muscle SF, with stimulation having no effect (P = 0.63) on SF within the SM. The effect of hang on SM SF was highly significant, with TS reducing SF by 9.5 N. This is again in agreement with previous literature on alpaca [7].

IV. CONCLUSION

Tenderstretching of alpaca carcases resulted in improved tenderness of the hind quarter. Electrical stimulation improved tenderness of the LL. These findings demonstrate that TS and ES should be applied to alpaca carcases in combination in order to maximise tenderness on a whole carcase basis.

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